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INTRODUCTION.

Each successive year of the war has made it necessary to limit to a constantly increasing extent the normal work of the Station, and to divert attention to matters of more immediate urgency arising from the prevailing conditions. This effect has been more pronounced during 1918 than in the preceding three years. As in 1917, the Station has been entirely deprived of the services of Capt. Gimingham and Dr. Lechmere. The time of the Director has mainly been taken up with technical work for the Fruit Supplies and Preservation Branch of the Ministry of Food, which has necessitated his presence in London for the greater part of each week. Mr. Lees and Mr. Spinks have been continuously occupied with teaching work in connection with the course of training in fruit culture which has been conducted during the year at the Station on behalf of the Ministry of Pensions, in which also for the latter part of the time Mr. Grove assisted. The advisory work of the Station showed an increase over that of the previous year and occupied a considerable proportion of the limited amount of the time remaining at the disposal of the staff. It was inevitable therefore that the volume of research in progress should be reduced greatly below the usual standard; and the investigations which have reached a stage suitable to report upon are few in number.

In view of the extremely difficult conditions under which the work has had to be conducted during the past four years it must be considered satisfactory to have reached the end of the war without more serious curtailment, and there is every prospect that work under normal conditions will be resumed very shortly. Capt. Gimingham's services are now again available, and Dr. Lechmere has returned after four years' internment in Germany.* The course of instruction in fruit culture for officers has been concluded, and it is hoped that no further calls of this nature on the

* Since this Report was sent to the press the Station has sustained a severe loss by the untimely death of Dr. Lechmere, who succumbed to an attack of pneumonia after a few days' illness.

Station will be necessary. The work for the Ministry of Food is nearly at an end, and it is expected that at an early date the whole of the scientific staff will be free from any outside demands on their time. There is also some prospect that additional assistants may be secured.

The position with regard to the work in the fruit plantations is less promising. During 1918 attention was concentrated on food production and the cultivation of the plantations was maintained very largely by the aid of soldier labour and of German prisoners. The incessant wet weather since the middle of July has, however, been a serious hindrance and all operations are in a very backward state. The prospects for labour in the immediate future are doubtful and it seems unlikely that the plans which had been arranged for 1919 can be fully carried out. To what extent they can be developed depends mainly on the weather during the first few months of the year and of the labour available during that period.

During 1918 the arrangements foreshadowed in the last Annual Report with regard to the acquisition of additional land have been completed and the Station has now about 53 acres of land at its disposal. Of the land recently acquired 13 acres of grass were broken up in the early part of the year and planted with spring wheat. About five acres of potatoes were also grown. The greater part of the remainder of the land was fully cropped with fruit and vegetables. Now that the food situation of the country has improved, it is intended to proceed with the planting of fruit for experimental work with all possible speed. A portion of the land is being devoted to nursery work, the stocks of fruit trees in the country having been reduced to a very low point. In view of the need for renovation of existing orchards in the West of England and for the formation of new orchards to replace the large acreage of those now too far worn out to be amenable to treatment further supplies of standard cider and perry trees will be raised as quickly as possible.

It is not proposed to enter into detail here concerning the numerous activities of the Station during the past year with regard to outside work, but the following summary will suffice to show that, although its normal research investigations have had to be restricted, it has been able to assist materially in many matters of immediate importance in which agriculture and horticulture have been concerned.

The utilisation of a portion of the superabundant cider fruit crop of 1917 by making a form of apple jelly was dealt with at some length in the Annual Report for that year. The whole of the produce for that season was disposed of very quickly in the early part of 1918, and a large demand had to remain unsatisfied. At the request of the Ministry of Food arrangements were then made for the manufacture of the jelly on a very much larger scale from the prospective

1918 crop of cider fruit, additional factories at Hele and Hereford being organised and equipped. The failure of the apple crop and the consequent need of the whole of the cider fruit crop for jam manufacture made it impossible to proceed with the original plans. The accompanying shortage of other fruits rendered it necessary for jam manufacturers to utilise blackberries, marrows and rhubarb to a much greater extent than heretofore. Since those materials produce jams which normally are deficient in setting properties, it was decided to remedy this defect by the use of the jellying material contained in cider fruit, and accordingly arrangements were made with the Ministry to produce at Long Ashton from freshly pressed pomace an apple extract which possessed the required setting properties. The result of this work has been to increase the jam supply by several hundred tons. A number of experiments were made for the Ministry in the direction of the manufacture of jam substitutes. Some interesting results were obtained, although occasion to proceed with production on a commercial scale did not arise, since the shortage of jam supplies did not reach a critical stage owing to the cessation of hostilities permitting the import of fruit.

The utilisation of cider fruit by the jam trade and for culinary and dessert purposes on the lines suggested in the last Annual Report intensified seriously for the cider trade the situation created by the failure of the crop, and there was at one period a risk that cider-making during the 1918 season would be prohibited. The action of the Institute, however, after consultation with representatives of the cider industry, resulted in a portion of the crop being secured by makers who were authorised to purchase apples for conversion into cider under a license issued by the Ministry of Food. In view of the need to increase the supply of drink a special allowance of sugar was granted by the Royal Commission on Sugar Supplies to enable the output to be increased by the making of "small" cider in the manner proposed in last year's Report.

A number of miscellaneous experiments on matters arising in connection with fruit and vegetable preservation have been made for the experimental factories of the Board of Agriculture at Dunnington and Broom Junction and also at the request of the Horticulture Division of the Food Production Department.

For the Supplies Division of the same Department an extensive series of experiments on the spraying of potatoes for the prevention of "potato disease" or "late blight" (*Phytophthora infestans*) was carried out at Long Ashton. The Station also undertook on behalf of the same body the organisation of a scheme for spraying with horse-drawn machines the potato crop in Somerset, at the request of the War Agricultural Executive Committee of that county. Three machines were supplied by the Department for this purpose.

The county was divided into three main areas for the work and one machine was allocated to each area under the charge of specially-trained men. Soldier labour was provided and the men received their training at Long Ashton. In spite of bad weather which supervened for three or four weeks at the most critical point of the spraying season, over 150 acres of potatoes were dealt with in the county under this scheme.

Acting in conjunction with the Food Production Department, the Institute has appointed a special Committee, including representatives of the counties of Devon, Gloucester, Hereford, Monmouth, Somerset, and Worcester, to deal with the question of the conditions of farm orchards in the West of England and to advise as to measures which can be taken to remedy the present unsatisfactory state of affairs. An endeavour is being made to ensure adequate representation on this committee of all interests concerned, and it is hoped that its labours will result in material benefit not only to agriculturists in the western counties, but also to the fruit, cider and other related industries.

On behalf of the Ministry of Pensions, a year's course of training in fruit culture for partially disabled officers was begun at the Station in February, 1918, for which thirteen selected men entered. The varying degrees of disability of the students rendered it extremely difficult to conduct the course under satisfactory conditions, but arrangements have been made for those who were able to complete it to supplement this preliminary training by a further year's experience on commercial fruit farms. The course consisted partly of lecture and laboratory work in chemistry, botany, and entomology in relation to horticulture and partly of practical training in the operations of fruit culture conducted in the fruit plantations at the Station.

In addition there have been taken up various investigations which have arisen through the work of the Natural Products Committee of the Royal Society and of the Fruit and Vegetable Preserving Committee of the Food Investigation Board of the Department of Scientific and Industrial Research, the Director having been appointed a member of both of these Committees.

During the year an Advisory Horticultural Committee of the Board of Agriculture and Fisheries was formed, and the Institute was invited to nominate two representatives, one to represent in particular the cider industry. Mr. Edward Bond, of Messrs. Wm. Evans & Co., Ltd. and the Director have been appointed to serve on behalf of the Institute.

Mr. Lees has been nominated to represent the Institute on the Horticultural Sub-Committee of the Somerset War Agricultural Committee.

In view of the recognised need for increased provision for education and research various schemes for the development of agriculture and horticulture in those directions are under consideration by the Board of Agriculture. At the request of the latter body a scheme has been prepared for the extension of research in fruit culture and related subjects, which will, if approved, ensure a considerable development of the Station at Long Ashton.

SINGLE VARIETY CIDERS AND PERRIES, 1917-18.

BY O. GROVE.

The experimental work with cider during the season 1917-18 was to a large extent suspended because of the making of the apple orchard jelly by concentration of cider apple juice. This work lasted from September, 1917, to February, 1918, and about 156,200lbs. of the jelly were made. The process was described in last year's report.

The single variety trials were upon a very reduced scale, only eight different varieties being dealt with, all of which had been tested in previous years.

The following varieties were used :—Cap of Liberty, Butter Box, Bickington Grey, Gatcombe, Kingston Black, White Norman, Never Blight, and Chisel Jersey. Of these Butter Box, Gatcombe, and Chisel Jersey produced ciders of merit. The first, especially, was a very good cider. The other five varieties did not produce ciders up to the standard of earlier years. They were rather thin and featureless, lacking also in bouquet. This was largely caused by the low specific gravity of the juices. As usual in a year with a heavy crop the gravities were very low. Only in a very few cases did they reach 1.050. The great majority of the juices used for cider and for jelly making had gravities of 1.042-1.045 only.

ANALYSES OF SINGLE VARIETY CIDERS.

Name of Variety.	Composition of Juice.			Specific Gravity, May, 1918.
	Specific Gravity.	Malic Acid per cent.	Tannin per cent.	
Never Blight ..	1.048	.48	.20	1.018
Butter Box ..	1.045	.58	.15	1.022
Bickington Grey ..	1.050	.90	.20	1.023
Cap of Liberty ..	1.045	1.02	.21	1.026
Gatcombe ..	1.046	.60	.18	1.028
Kingston Black ..	1.048	.67	.17	1.031
White Norman ..	1.042	.29	.16	1.010
Chisel Jersey ..	1.058	.24	.45	1.024

NEW TRIAL CIDER AND PERRY ORCHARDS, 1917-19.

BY B. T. P. BARKER.

Since reference was last made to these orchards in the Annual Report for 1916, a few additional orchards have been established, particulars of which are given in the following tables. During the two planting seasons, 1917-18 and 1918-19, 535 trees have been sent out from the nurseries of the station for this purpose and 127 trees have also been supplied for filling gaps in some of the earlier established orchards. In addition 553 trees were sold to Members and Associates of the Institute and 538 distributed for restocking old orchards.

The supply of trees of suitable size for planting in grass orchards is now practically exhausted and during the war it has been impossible to raise younger material to maintain succession. During the past year several thousand seedling stocks have been planted in a new nursery which has been formed and in due course the distribution of trees will be renewed on normal lines. There must, however, be a break for three or four seasons before the new stock is ready. Arrangements are being made for the planting of additional batches of seedling stocks annually to ensure a steady output of trees each year.

It has been impossible during the past two or three seasons to give much attention to the trial orchards already planted and for that reason no detailed report upon them is included. The altered situation created by the termination of the war will afford an opportunity for closer inspection by the staff of the Station in future. During the coming year a tour of the orchards will be arranged and a close examination of the results of the trials of individual varieties will be made.

NEW EXPERIMENTAL ORCHARDS PLANTED IN 1917-18.

CENTRE.	VARIETIES SELECTED.			
	APPLES.			PEARS.
	SHARP.	SWEET.	BITTERSWEET.	
<i>Worcester County Trees.</i> Charles Neath, The Bell, Pensax, A b b e r l e y, Worcester (200)	Porter's Perfection (5) Yellow Styre (5) Cap of Liberty (5) Yeovil Sour (5) Kingston Black (10) Cherry Pearmain (10)	Eggleton Styre (10) Sweet Alford (10)	White Close Pippin (10) Rouge Bruyère White Bache (10) Friveule (10)	Judge Amphlett (10) Taynton Squash (10) Claret (10) Hellens' Green (10) Barland (10) Pine (10) Barnet (10) Oldfield (10) Holmer (10) Lintot (10)
N. Crump, Suckley Court, Worcester (73)	Gatcombe (10) Dymock Red (10) Langworthy (4) Page's Yellow (5) Skyrme's Kernel (6) Foxwhelp (16) Kingston Black (11) .		Morgan Sweet (11)	

NEW EXPERIMENTAL ORCHARDS PLANTED IN 1918-19.

CENTRE.	VARIETIES SELECTED.				PEARS.
	APPLES.		SHARP.	BITTERSWEET.	
	SWEET.				
<i>Monmouth County Council.</i> R. H. Newill, Mon. Estate Office, Chesh- stow (80)	Reinette Obry (10) Eggleton Styre (11)	Horner (5)		Dabinett (15) Rouge Bruyère (15) Yarlington Mill (10) Medaille d' Or (5) Roussie (3) Harry Masters' Jersey (3) Royal Jersey (Butleigh) (3)	
G. G. Lewis, Church Street, Bedwas, Mon- mouth (98)	White Jersey (5)	Cap of Liberty (5) Dufflin (3) Hagloe Crab (3)		Fillbarrel (3) Royal Jersey (Crofts) (3) Butleigh No. 12 (5) Russet Jersey (3) Sandford Jersey (3) Royal Wilding (Hard- wicke's) (10) White Bache (5)	Claret (5) Dando (5) Hellens' Green (4) Holmer (5) Huffcap (4) Judge Amphlett (15) Moorecroft (5) Oldfield (2) Taynton Squash (5)
J. T. Marsh, Llwyn Oceil, Hardwick, Nr. Abergavenny (44)	Slack-ma-girdle (5) Sweet Alford (5) White Alphington (5)	Dymock Red (5) Skyrme's Kernel (3) Frederick (5)		Knotted Kernel (10) Butleigh No. 12. (3) Fréguin Audièvre (10) Royal Jersey (Butleigh) (3) Royal Wilding (5)	
W. P. Warren, Old Court, Llangattock, Lingoed, Abergavenny (40)				Old Cadbury (5) Major (10) White Close Pippin (10)	

POTATO SPRAYING TRIALS, 1917.

BY G. T. SPINKS.

An extensive series of potato spraying trials was carried out here in the Summer of 1918. The majority of the trials were arranged by the Food Production Department and were similar to other trials carried out at various centres. All the results here described were obtained on potatoes growing in the same field. Similar series of plots were arranged on (1) Up to Dates grown from Scotch seed ; (2) Up to Dates grown from local seed ; (3) King Edwards from Scotch seed and (4) King Edwards from local seed. In each case there were about forty plots, all the same size and shape. Each plot was $14\frac{1}{2}$ yards long and contained five rows of potatoes running lengthways, the rows being 30 inches apart. Each plot therefore had an area of two rods. One quarter of the plots were left unsprayed as controls, one quarter were sprayed twice with ordinary 1% Burgundy mixture, while the remaining plots received various treatments. As a comparison of the utility of various sprays the trials gave no result, hence it is not proposed to give a full description of all the sprays used. It is sufficient to say that most of the plots received two applications of one of the following sprays :— Bordeaux mixture, Burgundy, with various proportions of soda crystals, Burgundy made with special forms of soda, Burgundy with substances added to increase adhesive powers, proprietary mixtures including powders applied dry, and Copper Stearate. A few plots were sprayed only once, and some were sprayed three times. All the sprayings were done as thoroughly as possible with Knapsack machines.

The first spraying was done on June 21st and 22nd in unfavourable conditions, the weather being windy and showery. One point brought out by these trials was the good adhesive powers of practically all the mixtures under unfavourable circumstances. If only a Burgundy mixture has had time to dry it will not be washed off if heavy rain follows immediately. It was also found in several cases that a very good coating was left on the foliage when a drizzling rain fell before the deposit had even had time to dry properly.

The second application of spray was given on July 17th, no *Phytophthora* having yet been found on any of the plots. A few plots were sprayed also on July 31st, the potatoes all being quite healthy still. On August 3rd a careful examination revealed *Phytophthora* only on one plant of Up to Date and one plant of King Edward, the attack being very slight in each case. After that the disease made no progress for some time and it was not until about August 16th that it began to be widely distributed and at all noticeable. The lateness of the onset of the disease was presumably due to the character of the weather experienced in June, July, and the first half of August. The weather was almost always either hot, sunny and dry, or cold and rainy, and there was practically none of the warm, dull and moist weather which seems to be most favourable to the spread of *Phytophthora*. After August 16th, however, the disease spread rapidly, and by August 31st it was bad on the haulm on nearly all the plots. The King Edwards became diseased most rapidly, but the Up to Dates, although attacked about a week later, ultimately became just as badly diseased. No difference in susceptibility between plants from Scotch and local seed was noted.

In almost every case the sprayed plots were as badly diseased as those unsprayed. The only exceptions were those plots which had been sprayed on July 31st, which were protected against the "blight" to a marked degree, and showed up as green patches for several weeks after the rest of the plot had been blackened and stripped of leaves. It therefore appears that the mixtures (ordinary Burgundy and "Blighty") applied shortly before the disease appeared gave good protection; but the same and other mixtures applied a month before the appearance of the disease had no effect, probably owing to the quantity of new foliage formed in the meantime.

Under these circumstances no information concerning the relative fungicidal properties of the different mixtures was gained. As regards the covering and adhesive powers of the different mixtures no appreciable difference was found.

Owing to continuous wet weather the tubers could not be lifted until November, and the sound and blighted tubers from each plot were then weighed. Taking an average it was found that spraying had made practically no difference to the total crop or the percentage of diseased tubers obtained from a plot. It was surprising to find that the King Edwards, the haulm of which had been so badly blighted, only yielded $1\frac{1}{2}\%$ of tubers which could be identified as blighted at the time they were lifted. Two months later a small quantity which had not been clamped were still keeping well without showing any more disease, but it was not known how those in the clamp were keeping. Of the Up to Dates, $7\frac{1}{2}\%$ of the tubers from Scotch seed and 10% of those from local seed were seen to be blighted

at the time of lifting. Very many apparently sound tubers, however, developed blight a little later and so many became diseased that no clamping was done. It is thought that about two thirds of the tubers finally became diseased.

Apart from the spraying, these trials show very clearly the superiority, in this district, of Scotch over local seed. The local seed contained many rogues, large numbers of sets produced no plants at all, and the plants which did grow were much inferior to those grown from Scotch seed. But it is the weights of tubers produced which show most clearly the advantages of using Scotch seed. Local seed of Up to Dates produced $3\frac{3}{4}$ tons of tubers per acre, whilst Scotch seed of the same variety yielded $7\frac{1}{2}$ tons per acre. The figures of the crops of King Edwards are even more striking, local seed yielding $3\frac{3}{4}$ tons per acre, while the Scotch seed gave 10 tons per acre.

In addition to the above varieties of potatoes about half an acre of Scottish Farmer and a few rows of several other varieties were grown in the same field and gave some interesting information about their different degrees of susceptibility to *Phytophthora*. The most striking fact was the great resistance of Scottish Farmer to disease. On August 31st, when the haulm of Up to Dates was blackened and devoid of leaves, unsprayed Scottish Farmer growing next to it showed only occasional spots of disease; and on September 28th the Scottish Farmer was still green and only moderately diseased. The weight of tubers obtained from this variety was at the rate of $13\frac{1}{2}$ tons per acre, of which only $\frac{1}{3}\%$ were diseased. Provost was another variety which was resistant, though not so much so as Scottish Farmer. Arran Chief was less susceptible than Up to Date or King Edward, while May Queen was the most susceptible variety.

BURGUNDY MIXTURES AND OTHER COPPER SPRAYS.

BY G. T. SPINKS.

The Proportion of Washing Soda to be Used.—There appears to be some doubt as to the relative proportions of copper sulphate and soda which should be used in the preparation of Burgundy mixture. It is now usually suggested that a Burgundy mixture should contain 1% of copper sulphate, that is to say, 4lbs. in each 40 gallons, but there is a difference of opinion as to the quantity of soda required. The formula which has always been recommended by the Irish Board of Agriculture contains 5lbs. of washing soda to every 4lbs. of copper sulphate. Two years ago the English Board of Agriculture gave 4½lbs. of soda to 4lbs. of copper sulphate as the most suitable proportions, but last year they recommended the Irish formula. Pickering has for some time maintained that the theoretically correct proportions are 7.2lbs. soda to 4lbs. of copper sulphate, and that this mixture is the best one for practical use. The experiments now to be described were started as the result of enquiries and suggestions from the Mond Nickel Co. No attempt has been made to find the chemical composition of any of the mixtures, which have only been investigated with regard to their fungicidal properties and the nature of the deposits they give. In the first place it was suggested that the best mixture, using copper sulphate and washing soda, was produced by the use of 4.25 parts of soda crystals to 4 parts of copper sulphate. A Burgundy mixture when freshly made contains a light blue gelatinous precipitate which remains in suspension for some time, but which eventually changes to a dense green crystalline form if the mixture is left standing. The Mond Nickel Co. tested Burgundy mixtures made up from different formulæ by leaving them standing and noting how long the precipitate remained in the gelatinous condition. It was found that a mixture containing copper sulphate and soda in the proportion of 4 : 4.25 retained the precipitate in the gelatinous state for the longest time, and it was suggested that this was therefore the most suitable for use as a spray. A mixture in which the precipitate has changed to the crystalline state is, of course, useless for spraying, for even if it were fungicidal it would not adhere to plants and could not even be applied successfully with a spraying machine.

Laboratory trials of various mixtures similar to the above were carried out here, the mixtures in each case containing 1% of copper sulphate, while the amount of soda was varied. In every case, 200cc. of the mixture were put in a tall glass cylinder and the time which elapsed before the precipitate crystallised was noted. The following table shows the results of a number of trials :—

Trial.	Proportion of Copper Sulphate to Soda Crystals.				
	4 : 3·5	4 : 4·25	4 : 4·5	4 : 5	4 : 7·2
1 Precipitate crystal- lised in ..		3½ days	2½ days		
2 Ditto ..	21 days	6 days		3 days	
3 Ditto ..		3 days		1 day	7 days +
4 Ditto ..		3 days		1 day	14 days +
5 Ditto ..				1 day	7 days +
6 Ditto ..		2 days		1 day	7 days +
7 Ditto ..				1 day	7 days +
8 Ditto ..		2 days		1 day	
9 Ditto ..		3 days		1½ days	

It is seen from the above table that the 4 : 7·2 mixture produces the most stable precipitate. The 4 : 3·5 mixture also gave a very stable precipitate, but a mixture of this composition contains much copper in solution and will probably scorch foliage badly. In each trial the precipitate of the 4 : 4·25 mixture was more stable than that of the 4 : 5 mixture. The last two mixtures are identical in appearance and release a good deal of carbon di-oxide but the precipitate of the 4 : 7·2 mixture is of a deeper blue colour and there is no effervescence of carbon di-oxide.

It was soon found that the time required for crystallisation of a precipitate was really little, if any, indication of the utility of the mixture as a spray. In the first place, the changes which occur to a precipitate when left in suspension in excess of liquid do not occur under other circumstances. With the idea of testing the toxic action of the precipitates on root-hairs various seedlings were placed with their roots in contact with coatings of the precipitates on filter-paper which was kept damp. The precipitate was then in the form of a paste and it was found to retain its gelatinous consistency indefinitely. Also precipitates which were spread as thin films on glass slides, or actually sprayed on foliage, if once thoroughly dried did not afterwards show any visible change even after exposure to the weather. Secondly, if a mixture will give a good covering, with fungicidal properties, when sprayed on to the leaves of a plant, it is immaterial whether the mixtures crystallise slowly or quickly, so long as it does not crystallise in less than, say, 24 hours. For practical spraying work, owing to the difficulty of providing vessels for large quantities, Burgundy mixture is always made in quantities small enough to ensure its being used within

24 hours, and usually within only two of three hours of being made. The fact that a mixture will remain in a useful form for a number of days therefore seems to be very little recommendation for it.

The only tests of the relative values of different mixtures appear to be their covering and adhesive powers, their permanence, their effect on foliage and their fungicidal action as actually tested on fungus mycelium or spores.

The character of the coating given by the mixtures has been tried both in the laboratory on glass slides and in the open by spraying various plants. Drops of a well-stirred 4 : 4.25 mixture spread over glass slides leave a continuous coating when dry. This coating when viewed under the high power of a microscope appears to be colloidal in structure, and shows no crystals or other particles of any appreciable size, but when it is quite dry a network of cracks appears, owing to the contraction of the film. This film does not change in appearance on keeping in the laboratory, on exposure in a moist atmosphere, or even on exposure to rain, though in the last case the deposit is very gradually and uniformly washed away. A fresh deposit also shows in places colourless crystals, presumably mainly of sodium sulphate, left by the evaporation of the liquid of the mixture, but water will readily dissolve these and leave the film of copper compound untouched. A 4 : 5 mixture leaves an almost identical deposit with the same properties, the only difference being that a film left in a damp atmosphere so that drops of moisture condense on it produces groups of insoluble long blue crystals of some copper compound, but the film as a whole appears to be unaltered. A 4 : 7.2 mixture gives a rather less satisfactory deposit, as it is inclined to be lumpy and slightly crystalline instead of forming a quite continuous film. This deposit forms even more blue crystals than the 4 : 5 mixture when moisture condenses on it. The above observations are the result of a number of separate trials which all agreed fairly closely. Whether this formation of crystals of a copper compound affects the fungicidal value of the spray has yet to be determined, but it seems likely that the deposit as a whole will be made less toxic to fungi by the aggregation of part of its copper in groups of large crystals. Moreover, if all soluble matter is first washed off the dried deposit, then no formation of blue crystals occurs when the deposit is afterwards exposed to a damp atmosphere.

Mixtures of these compositions were also sprayed on to gooseberries and potatoes, and it was found that all the different mixtures gave good, almost identical, coatings which adhered well, even after rain. Leaves examined fourteen days after spraying showed no apparent difference between the deposit then and when freshly applied, except that cracks had appeared. No scorching of foliage was found on the potatoes, but in every case moderate scorching

occurred on the gooseberries (Keepsake and King of Trumps), there being no noticeable difference between the different mixtures in this respect. It might be noted here that different ways of making mixtures of the same composition were tried. It was found that it is rather better to pour a fairly strong solution of the copper sulphate slowly into a weaker solution of the soda than to add concentrated soda to weaker copper sulphate or to mix solutions of equal strength. By using the first method of mixing a more lasting gelatinous precipitate is formed.

The fungicidal action of the mixtures was examined in the laboratory and in the field. Preliminary tests of the effect of the precipitates on root-hairs were unsatisfactory but seemed to show that a fresh gelatinous precipitate had more toxic action than a crystalline precipitate. Numbers of tests have been made with germinating spores and it was found that the most convenient spores for this purpose were those of *Cladosporium fulvum* from tomato leaves. By growing tomatoes under suitable conditions a supply of this fungus can be obtained almost all the year round, and the spores germinate readily. The tests were all made in moist chambers on microscope slides. In the first tests the following procedure was adopted:—A drop of the Burgundy mixture was spread over half a coverslip and allowed to dry. Then a drop of water containing *Cladosporium* spores was placed on the coverslip so that half of it was on the plain glass and the other half over the precipitate: this also was allowed to dry and there were then a number of spores adhering both to the plain glass and to the fungicide. The coverslip was then used as the covering of a moist chamber, the spores, of course, being inside the chamber. Usually the spores on the control portions germinated well at ordinary room temperatures, but once or twice in very cold weather the use of an incubator was necessary to start germination. Occasionally no spores germinated even on the control portion of a culture, but when this happened there was never any germination on the sprayed portion, so these quite negative results can be ignored. Considering only the cases where some spores germinated it was found that in every case the spores on the control germinated well, while in half the trials no germination occurred on the deposit and in the remaining cases only a very small number of spores germinated. The same results were obtained with each of the different Burgundy mixtures. Where germinations took place over the deposit it was often found that the germinating spores were floating on the surface of small drops of water which had formed by condensation and were therefore not in contact with the fungicide at all. In other cases germ-tubes were growing into drops of water even though the spores were apparently in contact with the spray. In order to ensure better contact between the spores and the spray deposit later

cultures were prepared in a different manner, the water containing the spores being applied to the coverslip first, allowed to dry, and the drop of Burgundy mixture applied last. In this way the spores were covered by the deposit and contact was assured. In almost every trial of this nature the control spores germinated well, while in no case, whatever the type of Burgundy mixture used, did any germinations occur under the deposit. That this failure to germinate was not due simply to the spores being covered was shown by the fact that spores under similar films of non-fungicidal substances, such as a gelatine-tannin precipitate, germinated well.

Field tests of the relative fungicidal properties of the different mixtures unfortunately yielded no results. A number of plots of potatoes were sprayed, but the *Phytophthora* appeared so late in the season that the potatoes had made much new growth since the spraying was done and became badly diseased in every case.

The conclusions which can at present be drawn from these investigations may be summarised as follows:—The 4 : 7·2 mixture will keep for the longest time in a condition fit for spraying, while the 4 : 5 mixture crystallises most rapidly. The 4 : 4·25 and the 4 : 5 mixtures form equally good coverings when sprayed, but the 4 : 7·2 mixture is slightly inferior. All the mixtures adhere and resist rain equally well, and all are equal as regards the possibility of scorching foliage. Laboratory tests indicate that all the mixtures are equally effective as fungicides, but no satisfactory field tests have yet been made.

Preparation of Burgundy from a Ready-made Mixture.—Copper sulphate and soda crystals finely powdered, thoroughly mixed, and dissolved in water were found to produce a mixture very similar to that made in the ordinary way. The precipitate is perhaps slightly lighter in colour, it changes to the crystalline form rather more rapidly and the coating it produces is not quite so even: but these differences are extremely slight and a mixture so made appears to be quite as satisfactory as ordinary Burgundy mixture. Such a mixture of powdered copper sulphate and soda crystals cannot be kept, as it very soon begins to cake into solid lumps which are quite unsuitable for the preparation of a spray. If, however, the powdered mixture is made with the appropriate proportion of suitable anhydrous soda instead of soda crystals, then this mixture will keep indefinitely, and when dissolved in water produces a similar Burgundy mixture. A proprietary article, "Blighty," is a powder prepared on similar lines which keeps well and produces an equally satisfactory spray when simply dissolved in water. All the tests mentioned in the first part of this article have been repeated with these mixed powders, and from every point of view the resulting Burgundy mixtures have been almost indistinguishable from mixtures made in the usual way. The

precipitate formed, the coating left on spraying, and the fungicidal properties as tested in the laboratory all resemble those of Burgundy mixture as ordinarily prepared. Here again field trials were mainly without result, but plots of potatoes sprayed late in the season were protected from blight to the same extent as those sprayed at the same time with ordinary Burgundy mixture. The results of trials made with "Blighty" on potatoes in other parts of Somerset indicate that a spray made with this mixture is as effective as ordinary Burgundy mixture as a fungicide. Mixed powders of this kind require to be in a fine state of division in order that both the constituents may dissolve readily, and to be of any practical value the mixture must keep well without caking or deteriorating in any other way. Given these conditions it appears that such a powdered mixture will produce a quite satisfactory spray, and, of course, it is very convenient to use, not nearly so much weighing and measuring being required as when making Burgundy mixture in the usual way. When preparing a spraying mixture with a mixed powder it is important to add the powder to the water slowly, stirring all the time. If a large quantity of powder is added at once there is a great effervescence of carbon di-oxide and the mixture is also of an inferior quality.

Copper Stearate Spray.—An article dealing with the use of copper stearate as a fungicide appeared in our Annual Report for 1917. At that time little could be said about the fungicidal properties of this substance though it had been found to give a spraying mixture with very good covering and adhesive powers. This year further tests of its fungicidal properties have been made. In this case also field trials on potatoes unfortunately yielded no result owing to the disease appearing so long after the spraying had been done. Laboratory trials, however, were more successful. The effect of a copper stearate mixture on the germination of *Cladosporium* spores was tried exactly as described above in the case of Burgundy mixtures. It was found in a number of separate trials that a covering of copper stearate always prevented the germination of spores although the spores in the control parts of the culture germinated well. A spray of this character therefore appears to be as fungicidal as a Burgundy mixture. It is hoped to carry out a conclusive test in the field in the coming season.

“ REVERSION ” AND RESISTANCE TO “ BIG BUD ” IN BLACK CURRANTS.

BY A. H. LEES.

“ Reversion ” in black currants is marked by one or more of the following characters :—

- (1) The fruit “ runs off,” *i.e.*, at picking time either no berries are found on the string or only a very few undersized fruits instead of the many plump ones of the normal bush. These few berries may be at the base or at the top of the string.
- (2) There is an extensive growth of the laterals resulting in a crowded, instead of an open form of bush.
- (3) The internodes are abnormally long and thin.
- (4) The leaf is sharp pointed, abnormally narrow, with a more than usually serrate margin.

The disease is nearly always gradual in its appearance and frequently parts of a bush will show signs while the rest is quite healthy.

From the practical point of view the failure of the fruit is undoubtedly the most important point, and yet it is probable that the excessive development of lateral growth and the causes leading to it are more likely to supply a key to the problem.

The buds in a healthy shoot of black currant examined in the winter may be divided into two classes, wood and flower buds. It is not possible to distinguish them without dissection, but their structure and subsequent history differ considerably. Wood buds contain a single strong growing point wrapped round with leaf rudiments and occur at the base of the year's shoot and also usually as terminals.

The flower buds are composite, having a central flower rudiment with the two accessory weak lateral growing points. Most of the lateral buds in a last year's shoot are flower buds though their strength varies with their position.

Wood buds usually make a strong wood growth the following year. The terminal wood bud serves for normal extension of the bush while in vigorous bushes a few of the wood buds low down on the year's shoot also push out, thus serving to fill up spaces in the bush.

The flower buds put forth their flower in the Spring, set fruit and then make a short spur-like growth from one or both of the accessory growing points. Under normal circumstances the growth so made is never very long. The result of the evolution of these two kinds of buds is that the black currant makes long and strong terminal growth, each year's laterals producing at first flower buds and then short spur-like outgrowths. There is not, in a normal specimen, very much lateral wood formed.

From this description it would appear that where in a reverted bush undue lateral wood growth has taken place the cause must be looked for in some exceptional check to the terminal growing point. In growers' plantations it has been frequently noticed that reverted bushes are usually attacked by Big Bud the following year and this fact suggested that there is some relation between the two diseases. At Long Ashton reverted bushes were divided into classes in June according to the virulence of the attack and then examined again in the following winter for Big Bud. This was done for two years and it was then found that the badly reverted bushes were practically always badly attacked by Big Bud the following winter. There is little doubt therefore that the two diseases are closely connected. As to whether reverted bushes get Big Bud more easily than normal or whether mited bushes become reverted is not quite clear at present. Several types of reversion have been observed.

CASE 1.—Associated with moderate or large numbers of Big Buds. Common at Long Ashton.

In this type the terminal is attacked with mites sometime in June. This check may cause out-growth of the lateral buds situated below whose terminals may or may not become mited. If the mite attack is not very strong, terminal growth proceeds normally but the winter terminal bud is found to be a Big Bud. Consequently the following year the laterals below it make an unusual wood growth and the bush becomes filled up with thin wood shoots.

There are many minor variations, according to whether the shoot is strong or weak, or whether the mite attack is strong or weak, but the ultimate result is an undue development of lateral wood shoots.

CASE 2.—Reversion of a Big Bud resistant variety.

Through the kindness of Messrs. Seabrook, of Chelmsford, I was enabled to examine reverted shoots of their "Seabrook's

Black " variety. This variety would appear to be resistant to Big Bud in the east of England and yet it reverts.

An examination of such shoots revealed some interesting points. Beside normal buds four other kinds could be found.

- (a) Big Buds containing mite. These were very uncommon and practically always found low down on the shoot.
- (b) Round swollen buds like small Big Buds but containing no mite.
- (c) " Killed " buds, one-third the normal size, much more pointed, with a dead and dried up growing point.
- (d) " Blank " buds. In these cases there was no sign at all of the bud that should have been in the axil of the leaf scar.

Further examination led to the supposition that (a) and (c) were the result of mite attack, (d) were probably, and (b) possibly so.

Killed buds are due to a strong mite attack during the summer on a weak bud. As a result the growing point is killed and thus the mites themselves are starved. The variety becomes, therefore, resistant. This hypothesis was confirmed in the following summer when such cases were actually observed.

If, however, the bud is stronger, as in the earlier formed ones or in general in a wetter climate, the growing point is not killed and the bud subsequently becomes big. The evidence for these assertions may be found in a paper by the Author in the *Annals of Applied Biology*, Vol. v., No. 1.

This will explain, therefore, why Seabrook's Black develops Big Bud in the moister climate of Long Ashton while remaining almost free in the drier climate of East Anglia. The fact that mite attacks Seabrook's Black though it seldom produces Big Bud supplies a possible reason for this variety reverting, always supposing that interference with the terminal bud is a necessary factor.

CASE 3.—No mite or Big Bud present.

Cases of reversion can often be found in bushes where both Big Bud and mite appear to be absent. These cases are very puzzling and no satisfactory explanation can be given. In such reverted material of " Seabrook's Black " it was found that most of the terminal buds were flower buds. Measurements showed that flower buds were only formed at the terminals when growth was moderate or feeble.

In such a bush, therefore, one might have supposed that a definite terminal check would take place the following growing season. There would be no strong vegetative growing point at the apex of the shoot but only two very weak accessory growing points one on each side of the flower rudiment.

For a time, therefore, until one of these accessory growing points had definitely taken the lead and become strong the shoot might be expected to behave as if the terminal bud was a normal one but was suffering from a check. This attempt at an explanation does not, however, fit in with the facts. If a bush be deprived of its normal terminal buds in the early spring it does not revert though it should do so if the check to the terminal growing point was the only condition. What actually happens is that two or three buds just below take up the growth and themselves form new, though weak, leaders.

The lateral buds farther down are not stimulated and the bush resembles in no way a reverted specimen.

CASE 4.—Aphis attack.

Where aphid attacks a strongly growing shoot in summer time the lateral buds immediately below the attacked part become converted into leaders. This process causes the bush to become filled with wood shoots, causing in that way a superficial resemblance to the woody growth in a reverted bush.

CASE 5.—Through unknown causes.

A peculiar form of reversion occurs in very young bushes that have been cut down immediately after planting and therefore cannot be accounted for by any interference with the terminal growth. Instead of making the usual straight growth with broad leaves considerable branching occurs from the laterals made during the current season. The leaves are markedly pointed in shape and the fruit drops prematurely. In such cases reversion occurs before any possible interference with the terminal buds could take place and the explanation must be sought elsewhere. The evidence so far points to these cases being chance seedlings, but no certain conclusion can yet be drawn. With regard to reversion occurring in older bushes there seems to be no doubt that marked development of lateral wood is a concomitant, but whether this is a cause or an effect is difficult to say. It is equally conceivable that some cause makes for lateral bud development involving loss of supplies to the developing fruit as that same cause makes for loss of fruit so that the excess of food is forced into the lateral buds.

THE PRESERVING VALUE OF VARIOUS SPICES AND ESSENTIAL OILS.

BY O. GROVE.

Owing to the shortage of tins there was a danger of the waste of a portion of the 1918 tomato crop required for tomato pulp. The pulp is normally preserved in sterilised tins; but supplies of the latter being limited, the Ministry of Food desired to find an alternative method of preservation in cask without the addition of preservatives unsuited for food products.

Some experiments were accordingly carried out to find the preserving action of several spices and essential oils. The work was done with the assistance of Captain D. Jessop, of the Ministry of Food. Many of the substances used as spices or herbs, *e.g.*, thyme, mint, pepper, cloves, cinnamon, and others, contain bodies which act as strong deterrents upon bacteria and other micro-organisms causing deterioration of food, and the object of the experiment was to find out if some of those substances or mixtures of them could be used as keeping agents, preserving certain kinds of food for some time at least, and the amounts necessary to reach that object, without interfering too much with the flavour of the foods.

For the first series of experiments tomato-pulp was used. The tomatoes were pulped in the ordinary way, the pulp was put into bottles, the preserving substances added and a few drops of a mixture containing different kinds of micro-organisms (bacteria, mycoderma, yeasts and mouldspores). The open bottles were then placed in an incubator, where a temperature of 25°C. was maintained.

SERIES I.

Extracts of mustard, celery seeds, horseradish, cloves, allspice, and cinnamon in alcohol, water, and diluted acetic acid.

The alcoholic extracts were made by adding 10 grammes of the substance to 40 c.c. of an 80 per cent. alcohol and keeping the mixture for four days at 30°C. and filtering. In the case of the watery extract the substance was kept for one hour with four parts of water at 70°C., afterwards at 30°C. for four days and then filtered.

Substance.	Extracted with	Proportion added.	Result of Examination.
Mustard	.. Water ..	1%	.. Apparently no check on
"	" " ..	2%	.. growth of the micro-
"	" " ..	3%	.. organisms added.
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 5% Acetic acid ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 80% Alcohol ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
Celery	.. Water ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 5% Acetic acid ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 80% Alcohol ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	.. Some check on the growth.
"	" " ..	5%	" "
Horseradish	.. Water ..	1%	.. No check on the growth.
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 5% Acetic acid ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 80% Alcohol ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	.. Some check on the growth.
"	" " ..	4%	" "
"	" " ..	5%	" "
Cloves	.. Water ..	1%	.. No check on the growth.
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 5% Acetic acid ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 80% Alcohol ..	1%	.. Some check on the growth,
"	" " ..	2%	" "
"	" " ..	3%	.. Growth completely stopped.
"	" " ..	4%	" "
"	" " ..	5%	" "
Allspice	.. Water ..	1%	.. No check on the growth.
"	" " ..	2%	" "

Substance.	Extracted with	Proportion added.	Result of Examination.
Allspice	.. Water ..	3%	.. No check on the growth.
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 5% Acetic acid ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 80% Alcohol ..	1%	" "
"	" " " ..	2%	" "
"	" " " ..	3%	" "
"	" " " ..	4%	" "
"	" " " ..	5%	" "
Cinnamon	.. Water ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 5 % Acetic acid ..	1%	" "
"	" " ..	2%	" "
"	" " ..	3%	" "
"	" " ..	4%	" "
"	" " ..	5%	" "
"	.. 80% Alcohol ..	1%	" "
"	" " " ..	2%	" "
"	" " " ..	3%	.. Some check on the growth.
"	" " " ..	4%	" "
"	" " " ..	5%	" "
Horseradish	.. Scraped and added to boiling pulp	4%	.. " "

As will be seen from the above table, the growth of the added micro-organisms was completely stopped by an addition of 3, 4 and 5 per cent. of an alcoholic extract of cloves, and the development was checked by 4 per cent. and 5 per cent. of an alcoholic extract of celery seeds, by 3, 4 and 5 per cent. of an alcoholic extract of horseradish, by 1 per cent. and 2 per cent. of an alcoholic extract of cloves, by 3, 4 and 5 per cent. of an alcoholic extract of cinnamon, and by 4 per cent. of scraped horseradish. In all the other cases the additions did not seem to have any unfavourable action upon the development of the micro-organisms. In all the cases the bottles were kept open, this being done to make the test more severe. If the treated pulp had been put into completely filled and well closed bottles the results would presumably have been more favourable, especially as far as the growth of moulds and mycoderma are concerned.

The next series of experiments were carried out with the essential oils of cloves and cinnamon and combinations of the oils with salt and scraped horseradish.

The following experiments were carried out with essential oils. Malt extract was used instead of tomato pulp. The samples were inoculated with the same mixture of active micro-organisms as above and kept in the incubator.

SERIES II.

Oil of Clove.	Oil of Cinnamon.	Salt.	Horseradish.	Result of Examination.
·01%				No check on growth of the micro-organisms added.
·02%				" " "
·03%				" " "
·04%				" " "
	·001%			" " "
	·005%			" " "
	·01%			" " "
·02%	·001%			" " "
·02%	·002%			" " "
·02%	·005%			" " "
·02%	·001%		1%	" " "
·02%	·002%		1%	Slight check on growth.
·03%	·01%	2%	1%	Some check on growth.
·03%	·02%	2%	1%	Decided check on growth.
·03%	·03%	2%	1%	Growth completely stopped.
·04%	·005%	2%	1%	No check on growth.
·04%	·01%	2%	1%	Same check on growth.
·04%	·02%	2%	1%	Decided check on growth.
·04%	·04%	2%	1%	Growth completely stopped.
·05%	·01%	2%	1%	Decided check on growth.
·05%	·03%	2%	1%	Growth completely stopped.
·05%	·05%	2%	1%	" " "

SERIES III.

Name of Oil.	Percentage.	Result of Examination.
Absinth	·1%	Some check on growth.
Almonds	·1%	" " "
Juniper	·1%	" " "
Nutmeg	·1%	" " "
Lemon	·1%	" " "
Lime	·1%	" " "
Orange	·1%	" " "
Sage	·1%	" " "
Thyme	·1%	" " "
Rosemary	·1%	" " "
Lavender	·1%	" " "
Camphor	·1%	" " "
Eucalyptus	·1%	" " "
Cubeb	·1%	" " "
Cedar	·1%	" " "
Sandalwood	·1%	" " "
Savin	·1%	" " "
Pine	·1%	" " "
Peppermint	·1%	Decided check on growth.
Mustard	·1%	Growth completely stopped.
Spearmint	·1%	Decided check on growth.
Geranium	·1%	" " "
Rose	·1%	" " "
Bay	·1%	" " "
Origamun	·1%	Growth very nearly stopped.
Caraway	·1%	" " "
Aniseed	·1%	Growth completely stopped.
Parsley	·1%	Some check on growth.
Ginger	·1%	" " "
Pepper	·1%	" " "

In the last series of experiments combinations of some of the above oils were used.

cloves.	Aniseed.	Cinnamon.	Caraway.	Origanum.	Salt.	Result of Examination:
·06%	·06%	·06%	·06%	·06%		Growth completely stopped.
·02%	·02%	·02%	·02%	·02%		Ditto
·01%	·01%	·01%	·01%	·01%		Decided check on growth.
·008%	·008%	·008%	·008%	·008%		Some check on growth.
·006%	·006%	·006%	·006%	·006%		Ditto
·004%	·004%	·004%	·004%	·004%		Slight check on growth.
·002%	·002%	·002%	·002%	·002%		Ditto
·01%	·01%					Very slight check on growth.
·02%	·02%					Ditto
·03%	·03%					Some check on growth.
·04%	·04%					Ditto
·05%	·05%					Decided check on growth.
·01%	·01%	·01%				Very slight check on growth.
·02%	·02%	·02%				Ditto
·03%	·03%	·03%				Some check on growth.
·04%	·04%	·04%				Ditto
·05%	·05%	·05%				Ditto
·02%	·02%	·02%	·02%	·02%	1%	Growth nearly stopped.
·02%	·02%	·02%	·02%	·02%	2%	Ditto
·02%	·02%	·02%	·02%	·02%	3%	Ditto

The experiments were not further proceeded with, owing to a favourable alteration in the situation as regards tomato pulp, but, judging by the results obtained, it would seem possible to prepare a mixture of spices or essential oils which, when added in very small quantities to certain kinds of food, would act as a preserving agent and a flavouring agent at the same time. The oils of mustard, cloves, aniseed and cinnamon had a higher preserving value than any of the other kinds tried.

THE INFLUENCE OF CONCENTRATION OF SUGAR SOLUTIONS UPON THE GROWTH OF MICRO-ORGANISMS.

BY O. GROVE.

It often happens in jams and similar sugary preparations that fermentation sets up when they have been kept for some time, especially if they are put in a fairly warm place. This fermentation is generally caused by the growth of yeasts, or in a few cases by the development of bacteria or moulds capable of fermenting sugars. The jams depend principally upon the concentration of sugar as a preserving agent, if no antiseptics, *e.g.*, sulphurous acid, salicylic acid or others, have been added; and the higher the sugar content is, the better the jam will keep.

Experiments were made to find the percentage of sugar necessary to prevent development of yeasts, bacteria, and moulds. Sugar solutions of different strengths, to all of which were added 2 per cent. of malt extract to provide the necessary food for the micro-organisms, were sterilised at boiling point and after cooling inoculated with a drop of a mixture of several kinds of yeasts, mycoderma, torula, and bacteria, together with mould spores. As all jams contain a certain amount of organic acid the samples were acidified with varying quantities of citric acid and in some cases salt. The sugar used was ordinary cane-sugar containing 95 per cent. of pure sugar. The samples were kept at room temperature and the results obtained are given in the following tables.

After 14 days the results were very nearly the same as after seven days. The mould-growth in the 65 per cent. series had increased a little and a trace of mycelium had developed in the first two ($\cdot 1$ and $\cdot 2$ per cent.) of the 70 per cent. series; otherwise there was no difference.

After three months the results were the same as after one month. The only mould developed in all cases was the ordinary blue mould (*Penicillium glaucum*), although the samples had been inoculated with spores of several kinds. The growth was only on the surface of the liquids. According to these experiments yeasts and bacteria

RESULT OF EXAMINATION AFTER THREE DAYS—SUGAR PERCENTAGE.

	45%	50%	55%	60%	65%	70%
Citric Acid						
1%	Some mycelium formed. Liquid cloudy. Development of yeast and bacteria.	A little mycelium formed. Liquid clear. No development of yeasts or bacteria.	No development.	No development.	No development.	No development.
2%	"	"	"	"	"	"
3%	"	"	"	"	"	"
4%	"	"	"	"	"	"
5%	" (but less)	"	"	"	"	"
6%	" ()	"	"	"	"	"
7%	" ()	"	"	"	"	"
8%	" (very little)	"	"	"	"	"
9%	No development.	No development.	"	"	"	"
1%	"	"	"	"	"	"
1.2%	"	"	"	"	"	"
1.4%	"	"	"	"	"	"
1.6%	"	"	"	"	"	"
1.8%	"	"	"	"	"	"
2%	"	"	"	"	"	"
Salt.						
5%	Some mycelium formed. Liquid clear. No development of bacteria and yeasts.	"	"	"	"	"
1%	"	"	"	"	"	"
1.5%	"	"	"	"	"	"
2%	"	"	"	"	"	"
3%	"	"	"	"	"	"
4%	"	"	"	"	"	"
Control.						
	Some mycelium formed. Liquid cloudy. Development of bacteria and yeasts.	A little mycelium formed. Liquid clear. No development of yeasts or bacteria.	"	"	"	"

RESULT OF EXAMINATION AFTER SEVEN DAYS—SUGAR PERCENTAGE.

	45%	50%	55%	60%	65%	70%
Citric Acid.						
1%	Mould growth. Deve- lopment of bacteria and yeast.	Mould growth only.	Mould growth only.	Mould growth only.	Feeble Mould growth only.	No develop- ment.
2%	"	"	"	"	"	"
3%	"	"	"	"	"	"
4%	"	"	"	"	"	"
5%	"	"	"	"	"	"
6%	"	"	"	"	"	"
7%	"	"	"	Feeble mould growth only.	" feeble mould growth only.	"
8%	"	"	"	"	"	"
9%	Mould growth. No development of yeasts or bacteria. Liquid clear.	"	"	"	"	"
1%	"	"	"	"	"	"
1.2%	Some mycelium formed. No development of bacteria or yeasts. Liquid clear.	"	"	"	"	"
1.4%	"	"	"	"	"	"
1.6%	"	"	"	"	"	"
1.8%	"	"	"	"	"	"
2%	"	"	"	"	"	"
Salt.	"	"	"	"	"	"
5%	Mould growth. Deve- lopment of bacteria and yeasts.	"	"	Mould growth only.	"	"
1%	"	"	"	"	"	"
1.5%	Mould growth only.	"	"	"	"	"
2%	"	"	"	Feeble mould growth only.	"	"
3%	"	"	"	"	"	"
4%	"	"	"	"	"	"
Control.	Mould growth. Deve- lopment of bacteria and yeasts.	"	"	"	Feeble mould growth only.	"

RESULT OF EXAMINATION AFTER ONE MONTH—SUGAR PERCENTAGE.

	45%	50%	55%	60%	65%	70%
Citric Acid.						
1%	Mould growth. Development of yeasts and bacteria, fermenting.	Mould growth only.	Mould growth only.	Mould growth only.	Mould growth only.	Very feeble mould growth only.
2%	" "	" "	" "	" "	" "	" "
3%	" "	" "	" "	" "	" "	" "
4%	" "	" "	" "	" "	" "	" "
5%	" "	" "	" "	" "	" "	" "
6%	" "	" "	" "	" "	" "	" "
7%	" "	" "	" "	" "	" "	" "
8%	" "	" "	" "	" "	" "	" "
9%	Mould growth. Very nearly clear. No fermentation.	" "	" "	" "	" "	" "
1%	" "	" "	" "	" "	" "	" "
1.2%	Mould growth. Liquid clear.	" "	" "	" "	Feeble mould growth.	No development.
1.4%	" "	" "	" "	" "	" "	" "
1.6%	" "	" "	" "	" "	" "	" "
1.8%	" "	" "	" "	" "	" "	" "
2%	" "	" "	" "	" "	" "	" "
Salt.						
5%	Mould growth. Development of yeasts and bacteria. Fermentation.	" "	" "	" "	Mould growth only.	Very feeble mould growth.
1%	" "	" "	" "	" "	" "	" "
1.5%	Mould growth. No development of yeasts and bacteria.	" "	" "	" "	" "	" "
2%	" "	" "	" "	" "	" "	" "
3%	" "	" "	" "	" "	" "	" "
4%	" "	" "	" "	" "	Feeble mould growth.	No development.
Control.	Mould growth. Development of yeasts and bacteria. Fermentation.	" "	" "	" "	Mould growth only.	Very feeble mould growth.

do not develop under the conditions mentioned above in a sugar solution of 50 per cent. or more. In a 45 per cent. solution development takes place if the acidity is below .8 per cent. At .9 per cent. it is very feeble indeed, and stops completely at an acidity of 1.2 per cent. An addition of salt of 1.5 per cent. also completely stops the development of yeasts and bacteria:

As regards the development of *Penicillium* the concentration necessary to check the growth is 65 per cent., but even at 70 per cent. there is a feeble growth after one month; the development is not completely stopped before the acidity is over 1 per cent. or the percentage of salt about 2 per cent. The mould-growth on the surface is very much influenced by the degree of moisture of the atmosphere, the drier the air the less the development. If samples are kept in a very dry atmosphere the growth stops at a lower concentration. This is due to the fact that evaporation takes place from the surface, and a thin layer of a higher concentration is formed, in which the mould spores do not germinate.

ADVISORY WORK.

The number of enquiries received through the post during the year was 173, as compared with 133 for the previous year, and with 205 during the year ended September 30th, 1916.

For the most part the enquiries were of a horticultural rather than an agricultural character, the majority being in connection with various plant diseases and pests, soil problems, and methods of preservation of fruit and vegetables.

The following table shows the source of the enquiries :—

Gloucester (including Bristol)	...	...	21
Hereford	...	...	2
Somerset	...	...	46
Wiltshire	...	...	0
Worcester	...	...	11
Counties outside the Bristol Province	...	...	93

The latter figure includes enquiries from Devon and Monmouth, which counties contribute an annual grant to the Institute.

Mr. C. T. Gimingham, the Adviser in Agricultural Chemistry, was absent during the whole year on War Office work, and matters with which he would normally have dealt, have received attention from other members of the Staff.

Horticulture.—The questions under this head which have been dealt with do not present any features of special interest, the nature of the problem in most cases being similar to those which have been referred to previously in earlier reports. The majority of the enquiries had to do with methods of preserving fruit and vegetables and with various products prepared therefrom. A large number of enquiries were referred to the Station through the Food Production Department and the Ministry of Food.

Diseases of Plants and their Treatment.—As in the previous year, several enquiries relating to diseases of potatoes were received. In view of the importance of the potato crop under the existing conditions, arrangements were made for conducting an extensive series of experiments on spraying, these being carried out in conjunction with the Food Production Department. In addition, the Station undertook the organization of a scheme of spraying the potato crops on the farms in Somerset with horse power sprayers.

Among the other diseases concerning which enquiry was made the following may be specifically referred to :—

Tomato Collar Rot, caused by a species of *Phytophthora*, recently named by Pethybridge *P. cryptogea*. This disease has been constantly brought to the notice of the Station during the past few years, and enquiries have been made concerning it which go to show that it is now very widely spread throughout the country, and causes very serious loss to raisers of tomato plants. An investigation on the subject is still in course of progress.

Arum Disease, caused by an attack of a species of *Rhizoctonia* at the root.

Raspberry Cane Disease (*Coniothyrium*).

Potato Collar Rot (*Verticillium*).

Economic Entomology. Enquiries through the post concerning identification of insects and advice for treatment amounted to 10, while 16 requests for advice concerned with spraying were received and answered. Six papers dealing with insect matters have been sent to correspondents asking for them of which two were to America.

Twelve separate visits were made in respect of enquiries in Horticulture or Economic Entomology.

Four proprietary articles used against insects were sent in for trial either by the makers or private persons. These were :—

1. Vaporite.
2. } Forms of concentrated Paraffin emulsion.
3. }
4. "Milton" fluid.

In addition arrangements were made and advice given to a person requiring to test certain fluids against insect pests at Long Ashton. Besides the visits already mentioned, made in response to definite requests, others were made during the year to fruit growers in the Advisory area. The object of these visits is of course to keep in touch as far as may be with any diseases that may appear during the year. Owing to the pressure of teaching work this side of the Advisory work has had to be somewhat curtailed.

Cider and Perry Making.—Many enquiries on this subject were made, the chief feature during the year being the comparatively large number of enquiries coming from districts outside the West of England. This is probably due to the fact that one result of the

very large apple crop of 1917 was the conversion of a portion of it into cider by many people who hitherto were not in the habit of making cider.

No fresh problems of particular interest have arisen during the year.

Special Investigations undertaken as the result of enquiries.—

- (1) *The Treatment of Rhizoctonia Disease of Asparagus.* The investigations on this subject have been referred to in previous reports. The field of trials is being continued at Badsey, near Evesham. Bleaching powder has given results of considerable promise when applied to the infected soil a fortnight before the planting of the crop.
- (2) *Apple Leaf Scorch.* Work on the subject is still in progress, and a considerable amount of additional information on the problem has been secured, the significance of which it is hoped to be able to determine during the course of a further series of pot experiments which are being started for the coming season.
- (3) *Tomato Collar Rot.* Laboratory investigation of this disease has been made, and the life history of the organism has been studied. It is not yet certain what is the original source of infection, but there is considerable reason to suppose that the water supply used for watering the plants may have much to do with the outbreaks. Further work is in progress.
- (4) *The Manurial Value of Horsehair Refuse.* The field trials started with this material during the previous year are in progress. It appears probable that the decomposition of the material in the soil is very slow, and that consequently the value of the high nitrogen content will not be secured until considerable time has elapsed after application of the material to the soil.

Mangel Analyses.—The Mangel Variety Trials, which were started in the Bristol Province in 1915, have been temporarily suspended by the respective counties except in the case of Worcestershire. They were continued in that county in 1916, 1917 and 1918. As in previous years samples of all varieties under trial were forwarded to the Station for analysis, both at the time of lifting and also in the Spring after storage of the roots.

Chemistry.—In all cases where an analysis has been made it has been done by Mr. William Camps of this Station.

Six requests for advice on manuring for crops were answered.

Three total chemical analyses of soils were made and one for potash in an ash. In each case the figures given were accompanied with advice on suitable manuring, or in the case of the ash with advice as to its best disposal.

Two visits were made in connection with the above work.

Lastly, information was given to a person wishing to use liquid blood as a manure, especially in respect of physiological difficulties likely to be experienced when the blood had to travel some distance before application.

Miscellaneous Advisory Work.—At the request of the Somerset War Agricultural Committee a trial was made of a variety of Canadian tomato seed.

A case of excessive tillering of wheat, supposed to be due to some insect pest, turned out on investigation to be due to the strongly tillering autumn wheat, "White Benefactor," being planted at end of March. The field appeared like a grass field, and it was obvious that no harvest could be expected. Permission was obtained for the owner to plough it up.

Three visits were made to two places in connection with Apple Leaf Scorch, a subject referred to under Special Investigations.

A visit was made and advice given in respect to general horticultural treatment for a fruit plantation, the soil of which had been analysed for general suitability for fruit growing in 1915.

Advice was given as to suitability for fruit growing of a certain locality in Somersetshire. Three lectures dealing with Plant Disease work were given, two in Bristol and one at Wisbech.

Other enquiries under this head have for most part to do with matters arising in connection with fruit and vegetable products. Among them may be mentioned :—

The determination of water in jam.

The determination of sulphur dioxide in jam and fruit pulp.

The composition of various samples of strawberry and other fruit pulp.

The influence of sulphur dioxide on galvanised and other metal utensils used in fruit preserving.

The use of potatoes and other vegetable material in jam making.

The utilisation of Agar and other gelatinising materials in the fruit preserving industry.

The composition of dried vegetables.

The vitamine content of preserved vegetables and fruits.

The vitamine content of cider apple jelly.

The preparation of food products from yeast.

The composition of flue dust.

Methods of preservation of whey.

